III.10 PALEONTOLOGICAL RESOURCES

A paleontological resource is defined in the federal Paleontological Resources Preservation Act (PRPA) as the "fossilized remains, traces, or imprints of organisms, preserved in or on the earth's crust, that are of paleontological interest and that provide information about the history of life on earth" (16 United States Code [U.S.C.] 470aaa[1][c]). For the purpose of this analysis, a *significant* paleontological resource is considered to be of scientific interest, including most vertebrate fossil remains and traces, and certain rare or unusual invertebrate and plant fossils. A significant paleontological resource is considered to be scientifically important for one or more of the following reasons:

- The fossil extends the temporal (stratigraphic) or geographic distribution for a specific taxonomic group of fossils.
- It is a rare or previously unknown species.
- It represents an exceptionally high-quality, well-preserved and morphologically complete specimen.
- It preserves a previously unknown anatomical feature or exhibits other characteristic features which represent ontogenic, pathologic, or traumatic variations.
- It provides new information about the history of life on Earth.
- It has identified educational or recreational value.

Paleontological resources that may be considered *not* to have paleontological significance include those that lack provenance or context, lack physical integrity because of decay or natural erosion, or are overly redundant or otherwise not useful for academic research (Bureau of Land Management [BLM] Instruction Memorandum [IM] 2009-011; included in Appendix R2).

The intrinsic value of paleontological resources largely stems from the fact that fossils serve as the only direct evidence of prehistoric life. They are thus used to understand the history of life on Earth, the nature of past environments and climates, the biological membership and structure of ancient ecosystems, and the patterns and processes of organic evolution and extinction. Despite the tremendous volume of sedimentary rocks preserved worldwide and the enormous number of organisms that have lived during the vast expanse of geologic time, preservation of plant and animal remains as fossils is rare. Further, because of the infrequency of fossil preservation and the extinction of most fossilized species, fossils are considered nonrenewable resources. Once destroyed, a particular fossil can never be replaced. Essentially, paleontological resources include fossil remains and traces as well as the fossil-collecting localities and the geological rock units (e.g., formations) containing those localities. Knowing the geographic and topographic distribution of fossil-bearing rock units makes it possible to predict where fossils will, or will not, be encountered.

This chapter discusses applicable regulatory framework and the physical setting relevant to paleontological resources within the Desert Renewable Energy Conservation Plan (DRECP) area. The chapter provides site-specific details for individual ecoregion subareas and presents map data at a regional scale (1:750,000) commensurate with the programmatic nature of the Proposed LUPA. Appendix R1.10 includes 10 maps and 2 tables supporting this chapter. The maps illustrate fossil yield potential for the DRECP area, and the tables present the generalized Potential Fossil Yield Classification (PFYC) that goes with the maps. The PFYC developed for the entire DRECP area represents an estimate based on the available regional-scale geologic data; it is not meant to replace the project and site-specific identification and evaluation of potential paleontological resources. (See Section III.10.2, Baseline Inventory and Mapping Methodology.) Individual future renewable energy projects seeking approval from land management agencies would be required to evaluate paleontological resources at a project-level of detail and would need to use the most detailed geologic and paleontological data available as part of project-level assessments.

III.10.1 Regulatory Setting

This section identifies protections for paleontological resources as provided under regulations and applicable ordinances. In recognizing that paleontological resources include not only actual fossil remains and traces, but also the fossil-collecting localities and the geological formations containing those fossils, BLM established guidelines for evaluating the paleontological resource potential of individual geological rock units. This procedure, discussed more fully in Section III.10.1.3, Bureau of Land Management Plans and Guidelines, utilizes the PFYC to assign ranks to individual rock units. The BLM has also developed standards for the assessment and mitigation of impacts of BLM management actions on paleontological resources (BLM IM 2008-009; 2009-011).

III.10.1.1 Federal Regulations

The management and preservation of paleontological resources on public lands are governed under various laws, regulations, and standards, including the Paleontological Resources Preservation Act summarized in this section. Additional statutes for management and protection include the Federal Land Policy and Management Act (Public Law 94–579, codified at 43 U.S.C. 1701–1782 and 18 U.S.C. 641), which penalizes the theft or degradation of property of the U.S. Government. Other federal acts—the Federal Cave Resources Protection Act (16 U.S.C. 4301 et seq.) and the Archaeological Resources Protection Act (16 U.S.C. 470 et seq.)—protect fossils found in significant caves or in association with archeological resources. The BLM has also developed general procedural guidelines (Manual H-8720-1; IM 2008-009; IM 2009-011) for the management of paleontological resources.

Paleontological Resources Preservation, Omnibus Public Land Management Act, Public Law 111-011, Title VI, Subtitle D. The Omnibus Public Land Management Act, Paleontological Resource Preservation Subtitle (16 U.S.C. 470aaa et seq.), directs the secretaries of the Department of the Interior and the Department of Agriculture to manage and protect paleontological resources on federal land using scientific principles and expertise. (This act is known by its common names, the Omnibus Act or the Paleontological Resources Preservation Act.) The Paleontological Resources Preservation Act incorporates most of the recommendations of the report of the Secretary of the Interior titled "Assessment of Fossil Management on Federal and Indian Lands" to formulate a consistent paleontological resources management framework. In passing the Paleontological Resources Preservation Act, the U.S. Congress officially recognized the scientific importance of paleontological resources on some federal lands by declaring that fossils from these lands are federal property that must be preserved and protected. The act codifies existing policies of BLM, National Park Service, U.S. Forest Service, Bureau of Reclamation, and the U.S. Fish and Wildlife Service, and provides:

- Uniform criminal and civil penalties for illegal sale and transport, theft, and vandalism of fossils from federal lands.
- Uniform minimum requirements for paleontological resource-use permit issuance (terms, conditions, and qualifications of applicants).
- Uniform definitions for "paleontological resources" and "casual collecting."
- Uniform requirements for curation of federal fossils in approved repositories.

Federal legislative protections for scientifically significant fossils apply to projects that take place on federal lands (with certain exceptions, such as the Department of Defense, which continue to protect paleontological resources under the Antiquities Act). Such protections involve federal funding, require a federal permit, or involve crossing state lines.

Antiquities Act of 1906 (16 U.S.C. 431-433). The Antiquities Act of 1906 states, in part:

> Any person who shall appropriate, excavate, injure or destroy any historic or prehistoric ruin or monument, or any object of antiquity, situated on lands owned or controlled by the Government of the United States, without the permission of the Secretary of the Department of the Government having jurisdiction over the lands on which said antiquities are situated, shall upon conviction, be fined in a sum of not more than five hundred dollars or be

> imprisoned for a period of not more than 90 days, or shall suffer both fine and imprisonment, in the discretion of the court.

Although there is no specific mention of natural or paleontological resources in the Antiquities Act, or in the act's uniform rules and regulations (43 Code of Federal Regulations [CFR] 3), "objects of antiquity" has been interpreted by the National Park Service, BLM, the U.S. Fish and Wildlife Service, and other federal agencies to include fossils. Permits to collect fossils on lands administered by federal agencies are authorized under this act. Therefore, projects involving federal lands will require permits for both paleontological resource evaluation and mitigation efforts.

Archaeological and Paleontological Salvage (23 U.S.C. 305). Statute 23 U.S.C. 305 amends the Antiquities Act of 1906. Specifically, it states:

> Funds authorized to be appropriated to carry out this title to the extent approved as necessary, by the highway department of any State, may be used for archaeological and paleontological salvage in that state in compliance with the Act entitled "An Act for the preservation of American Antiquities," approved June 8, 1906 (PL 59-209; 16 U.S.C. 431-433), and State laws where applicable.

This statute allows funding for mitigation of paleontological resources recovered pursuant to federal aid highway projects, provided that "excavated objects and information are to be used for public purposes without private gain to any individual or organization" (Federal Register 46[19]; 9570).

National Registry of Natural Landmarks (16 U.S.C. 461-467). The National Natural Landmarks Program, established in 1962, is administered under the Historic Sites Act of 1935. Regulations were published in 1980 under 36 CFR 1212 and the program was re-designated as 36 CFR 62 in 1981. A National Natural Landmark is defined as:

> … an area designated by the Secretary of the Interior as being of national significance to the United States because it is an outstanding example(s) of major biological and geological features found within the boundaries of the United States or its Territories or on the Outer Continental Shelf (36 CFR 62.2).

National significance describes:

> … an area that is one of the best examples of a biological community or geological feature within a natural region of the United States, including terrestrial communities, landforms, geological features and processes,

habitats of native plant and animal species, or fossil evidence of the development of life (36 CFR 62.2).

Federal agencies and their agents should consider the existence and location of designated National Natural Landmarks, and of areas found to meet the criteria for national significance, in assessing the effects of their activities on the environment under Section 102(2)(c) of the National Environmental Policy Act (42 U.S.C. 4321). The National Park Service is responsible for providing requested information about the National Natural Landmarks Program for these assessments (36 CFR 62.6[f]). However, other than consideration under the National Environmental Policy Act, National Natural Landmarks are afforded no special protection. Furthermore, there is no requirement to evaluate a paleontological resource for listing as a National Natural Landmark. Finally, project proponents (state and local) are not obligated to prepare an application for listing potential National Natural Landmarks, should such a resource be encountered during project planning and delivery.

Examples of geological and paleontological National Natural Landmarks in or near the DRECP area include:

- ***Imperial Sand Hills:*** Imperial Sand Hills is one of the largest dune patches in the United States. It is an outstanding example of dune geology and ecology in an arid land (Designated: 1966. Ownership: federal, private).
- ***Eureka Dunes:*** Eureka Dunes, located within Death Valley National Park, is an excellent example of Aeolian (wind) geological processes. It is the tallest dune complex in the Great Basin biophysiographic province. The site contains an endangered grass genus, one species of which is the only plant capable of surviving on and stabilizing the steep dune slopes (Designated: 1983. Ownership: federal).
- ***Amboy Crater:*** Amboy Crater is an excellent example of a recent volcanic cinder cone with an unusually flat crater floor (Designated: 1973. Ownership: federal, private).
- ***Rainbow Basin:*** Comprising deep erosion canyons with rugged rims, Rainbow Basin is an outstanding example of geologic processes. The site also contains significant fossil remains and traces (e.g., footprints) of Miocene plants, insects, and land mammals (Designated: 1966. Ownership: federal).

National Historic Preservation Act of 1966 (National Historic Preservation Act; 16 U.S.C. 470). Section 106 of the National Historic Preservation Act does not apply to paleontological resources unless the paleontological specimens are found in culturally related contexts (e.g., fossil shell included as a mortuary offering in a burial or a culturally related site such as petrified wood locale used as a chipped stone quarry). In such instances, the materials are considered cultural resources and are treated in the manner prescribed for the site in question. Mitigation is then almost exclusively limited to sites determined eligible for, or listed on, the National Register of Historic Places. Cooperation between the cultural resource and paleontological disciplines is expected in such instances.

III.10.1.2 BLM Plans and Guidelines

BLM Manuals, Handbooks, and Instruction Memoranda. BLM Manual 8270 and BLM Handbook H-8270-1 contain BLM's policy and guidance for the management of paleontological resources on public lands. The manual has more information on the authorities and regulations related to paleontological resources. The handbook gives procedures for permit issuance, requirements for qualified applicants, and information on paleontology and planning. The classification system for potential fossil-bearing geologic formations on public lands in the handbook has been revised and replaced by the PFYC, as discussed in this section.

The manual and handbook will be revised after the new regulations (currently being developed and reviewed) are promulgated under the PRPA. Until that time, BLM will continue to follow the policy and guidelines in the manual and handbook that are not superseded by the PRPA. The BLM's overarching guidance for paleontological resources is that locating, evaluating, and classifying paleontological resources and developing management strategies for them must be based on the best scientific information available. Management of paleontological resources should emphasize:

- The uniqueness of fossils.
- Their usefulness in deciphering ancient and modern ecosystems.
- The public benefits and public expectations arising from their scientific, recreational, and educational values.
- The BLM's interest in and need for the continued advancement of the science of paleontology.
- The importance of minimizing resource conflicts within a multiple use framework.

PFYC. On October 15, 2007, with the release of IM 2008-009, BLM formalized a new classification system for identifying fossil potential on public lands. This classification system is based on the presence of significant paleontological resources in a geologic unit and its potential risk for impacts to the resource. It is a broad approach to planning efforts and an intermediate step in evaluating specific projects. IM 2008-009 will be incorporated into the next update of BLM Handbook H-8270-1, General Procedural Guidance for Paleontological Resource Management.

Using the PFYC system, geologic units are classified as Class 1 (very low) through Class 5 (very high), based on the relative abundance of vertebrate fossils or scientifically significant invertebrate or plant fossils and their sensitivity to adverse impacts. A higher class number indicates a higher potential for adverse environmental impacts. This system is used to set management policies and is not intended to apply to specific paleontological localities or small areas within geologic units. Table III.10-1 defines each class and recommended management actions.

Table III.10-1
Potential Fossil Yield Classification System Class Definitions (BLM)

Class	Definition
Class 1 (very low)	Geologic units not likely to contain recognizable fossil remains. Management concern is negligible or not applicable; and assessment or mitigation requirements are usually not necessary, with the exception of isolated circumstances.
Class 2 (low)	Sedimentary geologic units not likely to contain vertebrate fossils or significant nonvertebrate fossils. Management concern is generally low; and assessment of mitigation is usually not necessary, with the exception of isolated circumstances.
Class 3 (moderate or unknown)	Fossil-bearing sedimentary geologic units where fossil content varies in significance, abundance, and predictable occurrence, or units of unknown fossil potential. Management concern is moderate or cannot be determined from existing data. Ground-disturbing activities may require field assessment to determine the appropriate course of action.
Class 3a (moderate potential)	Units are known to contain vertebrate fossils or scientifically significant nonvertebrate fossils, but these occurrences are widely scattered. Common invertebrate or plant fossils may be found in the area, and opportunities may exist for hobby collecting. The potential for a project to be sited on or impact a significant fossil locality is low but somewhat higher for common fossils.
Class 3b (unknown potential)	Units exhibit geologic features and preservational conditions that suggest significant fossils could be present, but little information about the paleontological resources of the unit or the area is known. This may indicate the unit or area is poorly studied, and field surveys may uncover significant finds. The units in this class may eventually be placed in another class when sufficient surveys and research are performed. The unknown potential of the units in this class should be carefully considered when developing any mitigation or management actions.
Class 4 (high)	Geologic units containing a high occurrence of significant fossils. The probability for impacting significant paleontological resources is moderate to high and depends on the proposed action. Anticipated impacts to significant fossils would usually require a field survey, followed by on-site paleontological monitoring or spot-checking.

Table III.10-1
Potential Fossil Yield Classification System Class Definitions (BLM)

Class	Definition
Class 5 (very high)	Fossil-rich geologic units that regularly produce vertebrate fossils or significant nonvertebrate fossils at risk of natural degradation or human-caused adverse impacts. The probability of impacting significant fossils is high, and fossils are known or can reasonably be expected to occur in the impacted area. Anticipated impacts to significant fossils would usually require a field survey, followed by on-site paleontological monitoring or spot-checking.

Assessment and Mitigation of Potential Impacts to Paleontological Resources. On October 10, 2008, BLM introduced guidelines for assessing potential impacts to paleontological resources to determine mitigation steps for federal actions on public lands covered under both the Federal Lands Policy and Management Act of 1976 and the National Environmental Policy Act (IM 2009-011). This IM provides field survey and monitoring procedures to help minimize impacts to paleontological resources in cases where a federal action could adversely affect significant paleontological resources.

These assessment and mitigation guidelines show the conditions under which no specific paleontology assessment is required, including when:

1. A project will only affect geologic units unlikely to contain significant fossils or that have a very low or low potential for significant fossils (i.e., PFYC Class 1 or 2).
2. No scientifically important localities are identified in the area.

However, pre-project field surveys, a paleontological monitoring program, or other mitigation measures may be needed if a project would disturb geologic units assigned PFYC classes 3, 4, or 5, possible fossil-bearing alluvium, or known significant localities. The BLM guidelines also outline procedures for conducting field surveys and monitoring on-site surface-disturbing activities. Assessment and mitigation guidelines are described in Volume IV, Chapter IV.10, Paleontological Resources.

III.10.2 Baseline Inventory and Mapping Methodology

Due to the immensity of the DRECP area and the wide variety of its landscapes and rock units, the most useful means of approximating the potential fossil yields in ecoregion subareas is by using geologic rock distributions in published reports. The distribution of paleontological resources is directly linked to the distribution of the geologic rocks preserving those resources. The BLM's PFYC system (described in Section III.10.1.3) utilizes this approach by assigning a specific PFYC ranking to individual rock units.

To support the analysis of impacts to paleontological resources in Chapter IV.10, a regional baseline inventory of the fossil yield potential of geologic rock within the DRECP area was developed. The regional scale of the geologic data used (1:750,000) means that the inventory is useful only in initial constraints analysis and for providing a general comparison of potential paleontological resource effects among alternatives. Assignment of geologic groups to various PFYC classes does not indicate where fossils may or may not be found, but rather suggests areas where the potential yield is higher relative to other locations assigned to lower PFYC classes.

As indicated in Table R1.10-1 (in Appendix R1) and in Figure III.10-1, a large body of geologic data is produced at various scales, to different extents, and with different formats to provide the baseline geologic data that determine PFYC classes. This environmental impact statement (EIS) relies upon the *2010 Geologic Map of California*, which is an updated and much improved version of a 1977 map, to identify potential fossil-yielding potential. It presents the geology of the DRECP area at a 1:750,000 scale (California Geological Survey 2013). The original map had accuracy errors that have been corrected. Data in the old version did not differentiate between Quaternary-age geologic units. In the 2010 version, older Pleistocene-age units are now differentiated from younger Holocene-age units. This distinction is important from a paleontological resources perspective because of the greater potential for Pleistocene deposits to contain fossil remains.

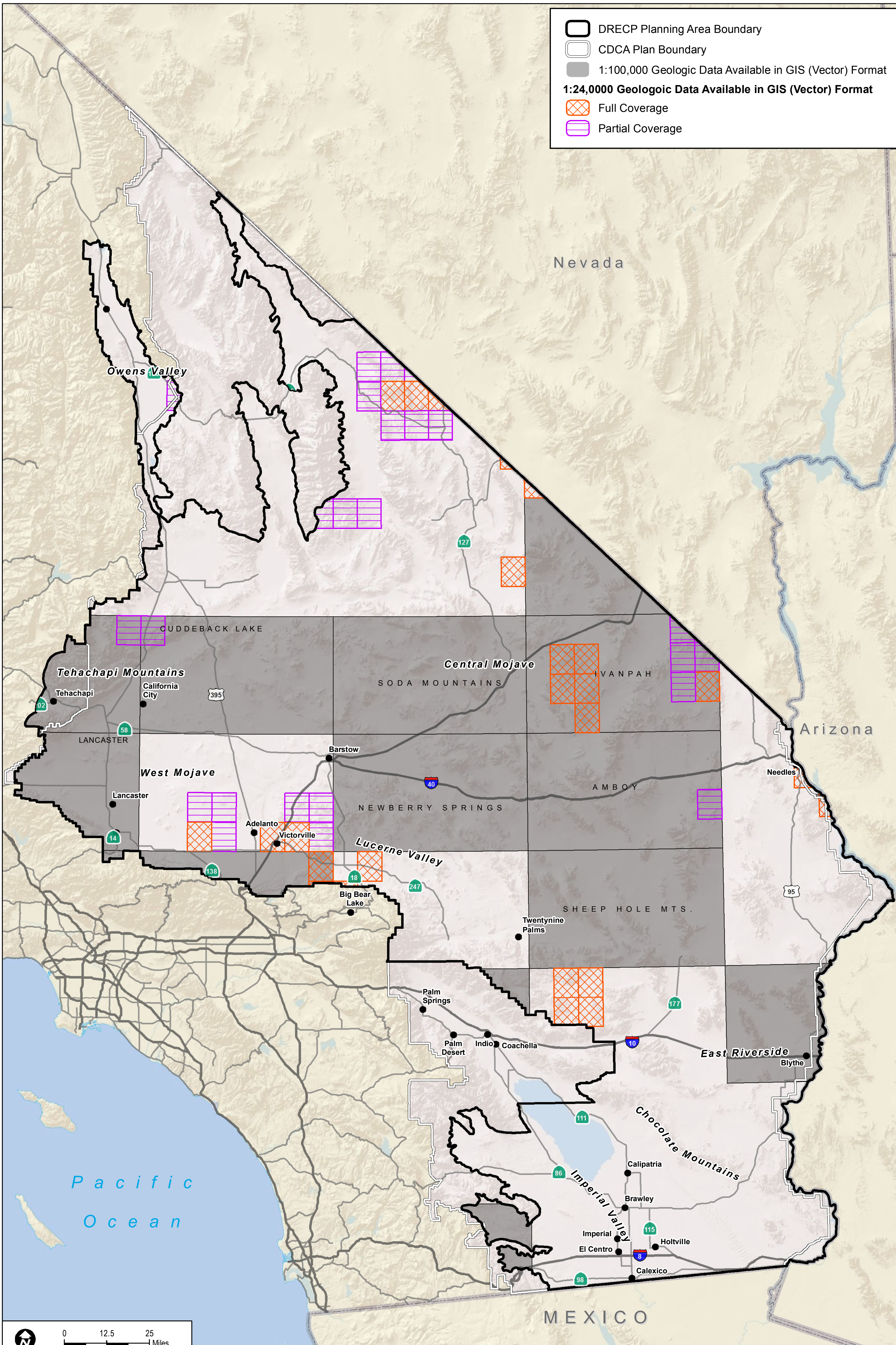
Relevant BLM guidance documents (IM 2008-009 and IM 2009-011), in combination with results from a comprehensive literature search of existing geologic and paleontological conditions in the DRECP area, were used to assign PFYC classes to the geologic rock units on the statewide map. Figure III.10-2 shows the PFYC ranking of rock units in each ecoregion subarea, and Table R1.10-2 (in Appendix R1) presents each geologic unit and its estimated PFYC class. The challenge with using statewide data is that some of the criteria for assigning PFYC classes require local, site-specific knowledge of individual geologic formations to assess their exposure to impacts. For example, because the higher PFYC classes are typically represented by individual geologic formations or stratigraphic layers within a formation, it would be misleading to classify a geologic rock unit at the 1:750,000 scale as PFYC Class 5. In addition, some rock units may predominantly belong to one PFYC class, while an individual formation or stratigraphic layer within that unit may be unusually fossil rich.

Because the geologic rock units at the 1:750,000 scale are so generalized, the PFYC classes are estimates and generalized in the same manner as shown in BLM IM 2009-011, Attachment 2, Paleontological Resources Assessment Flowchart. PFYC classes were grouped into three categories based on the level of management concern and the types of assessment and mitigation actions that could be required:

- **Low/Very Low:** Consists of PFYC Classes 1 and 2. Management concern is low, and assessment and mitigation is required only in rare circumstances. Even in those cases, the estimated PFYC must be confirmed at a local level, and it must be demonstrated that no known paleontological localities exist within the paleontological Area of Potential Effect (e.g., record search, literature review).

- **Moderate/Unknown:** Consists of PFYC Class 3. Management concern is either moderate or cannot be determined from existing data. A written assessment would be required; and, depending upon the potential for impacts, a paleontological field survey and report would be needed. Further action, including project redesign and or a monitoring and mitigation plan, may be required depending on the results of the written assessment and field survey. Areas of unknown potential may be reassigned to a different PFYC class after further investigation.
- **High/Very High:** Consists of PFYC Classes 4 and 5. Management concern is high to very high. The probability of impacting significant paleontological resources is moderate to high, depending on the proposed action (i.e., extent and depth of disturbance). A field survey by a qualified paleontologist is probably needed to assess local conditions, and special management actions may be required.

The assignment of Quaternary units to PFYC classes was conservative, in recognition that numerous fossil discoveries have been made in areas where previous information and mapping suggested low paleontological potential. For example, although the PFYC system suggests assigning rock units younger than 10,000 years, as well as sand dune deposits, to PFYC Class 2, they were assigned Class 3 because these rock units can be thin and overlie older, more sensitive rock units. The modified PFYC used here includes some ranges because their rock units, although predominantly belonging to one class, could locally belong to a higher class. In assigning geologic rock units to ranges of sensitivity (Low/Very Low, Moderate/Unknown, or High/Very High), the higher class was used.



Sources: ESRI (2015); CEC (2013); BLM (2015); CDFW (2013); USFWS (2013); CA Department of Geology (2010)

FIGURE III.10-1

Index of Detailed Geologic Mapping Available in GIS (vector) Format

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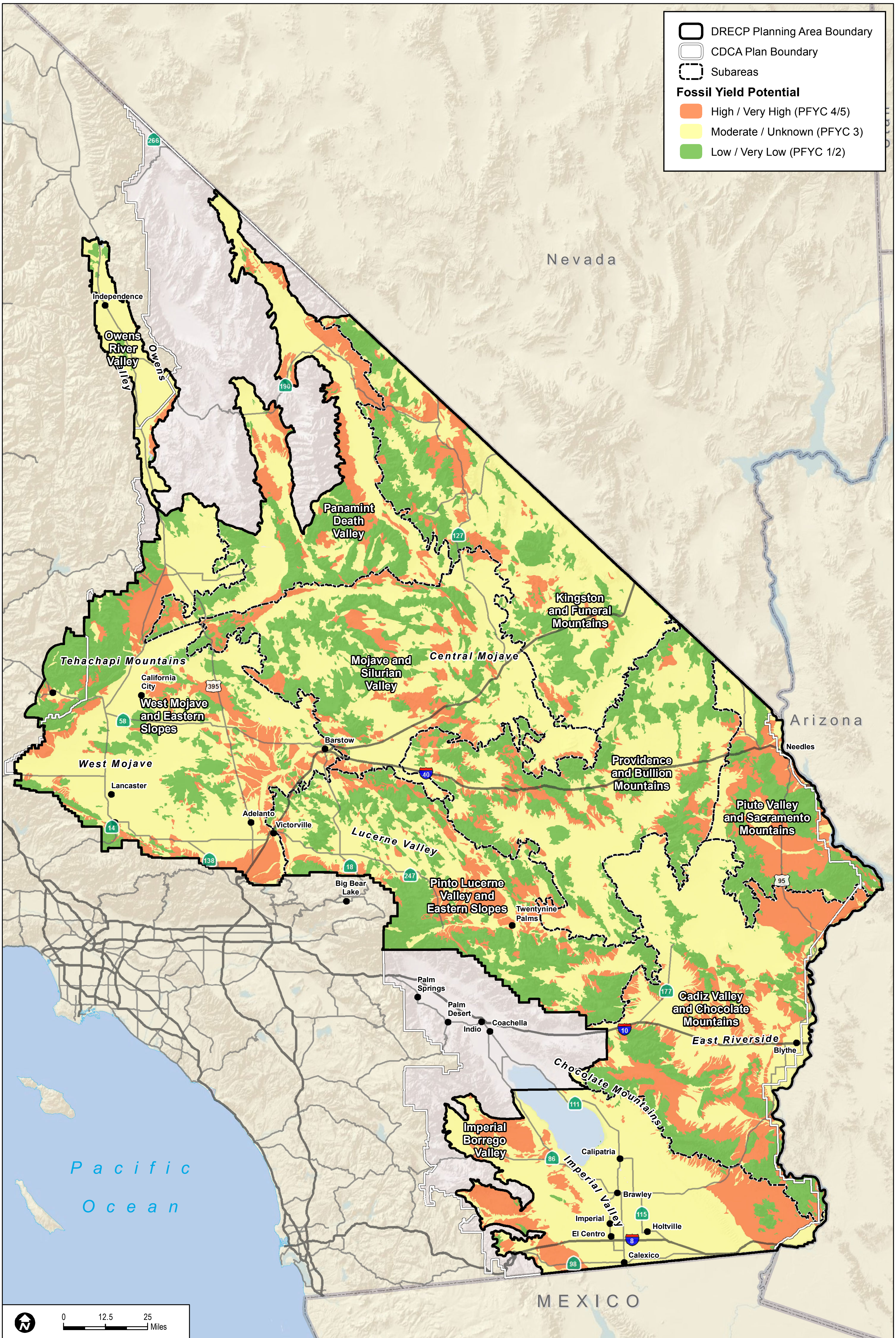

Sources: ESRI (2015); CEC (2013); BLM (2015); CDFW (2013); USFWS (2013); CA Department of Geology (2010)

FIGURE III.10-2

Potential Fossil Yield Classification of Geology - Subarea Index Map

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III.10.3 Overview of Paleontological Resources Within the DRECP Area

Statewide data regarding paleontological resources are reported in assorted publications, some of which compile various faunal lists for specific formations or periods. For example, paleontological resources inventories have been completed for National Park Service-administered lands within the DRECP area (Santucci et al. 2004). It is virtually impossible to digitally represent the full extent of buried paleontological fossil distribution. Fossils are normally underground, out of sight, and not easy to locate other than by direct observation either after erosion or during excavation. The likelihood of encountering subsurface paleontological resources in many of the southwestern valleys is not well known for several reasons. The land consists of mostly flat-lying sediments, thus natural erosion cuts through the sediments but does not penetrate deeply except in major stream channels, so the prior existence of subsurface and at-depth fossils is not readily determinable. Paleontology studies have focused on natural erosion in the surrounding hills and badlands where fossil exposures may be abundant in arroyo cuts and rain-washed hillsides.

Past and present discretionary projects proposed within the DRECP area have required varying degrees of baseline information on paleontological resources to be collected to support the analysis of paleontological resource impacts for specific projects, as required by the National Environmental Policy Act. Site-specific mapping of fossil yield potential and mitigation implementation, where deemed necessary, has provided important knowledge about the presence, distribution, and importance of fossil resources within the DRECP area. Such information, however, is generally scarce, highly localized, and specific to individual geologic formations. Furthermore, previous mitigation reports of existing developments in the flat-lying areas are not well indexed for convenient public access; they often exist only in BLM or other local repository offices. Some peer-reviewed publications are also describing fossil finds, especially by museums performing mitigation. Projects requiring assessment of and impact mitigation to paleontological resources within the undeveloped desert landscape have been few and far between, though they are generally located near transportation corridors and energy infrastructure.

III.10.3.1 Summary of Paleontological Resources Known in the DRECP Area

Since the late nineteenth century, geologists and paleontologists have been exploring exposed rock outcrops in Southern California's Mojave and Colorado desert regions; in the process they have discovered and documented a rich fossil record extending back to at least the middle Proterozoic Eon, about 1.2 billion years ago. The oldest fossils (~990 mega-annum [Ma], or 990 million years ago) from the DRECP area consist of microscopic single-celled bacteria and algae preserved in marine sedimentary rocks exposed in the

Nopah Range, in the Kingston and Funeral Mountains ecoregion subarea. Younger fossils from the same area, approximately 600 million years old, are among the oldest examples of metazoan animals identified in the western United States. Farther west in the DRECP area, marine limestones exposed in the Providence Mountains and Marble Mountains, in the Providence and Bullion Mountains ecoregion subarea, preserve fossils of Early Cambrian age (~540 to 500 Ma) that document the dramatic increase in biological diversity at the beginning of the Paleozoic Era. These fossils include hard skeletal remains of coral-like archaeocyathids, primitive brachiopods, and trilobites. Younger Paleozoic (~541 to 252.2 Ma) strata exposed in the Providence Mountains and surrounding mountain ranges preserve marine invertebrate fossils (e.g., tabulate corals, brachiopods, gastropods, trilobites, and crinoids) of Ordovician (~485 to 444 Ma), Devonian (~419 to 359 Ma), Carboniferous (~359 to 299 Ma), and Permian (~299 to 252 Ma) age. These fossils document the existence of a relatively passive continental margin along the west coast of North America that persisted for almost 250 million years before plate tectonic movements near the Paleozoic-Mesozoic boundary (~250 Ma) transformed the continental margin into an area of active plate subduction. Igneous and volcanic arcs extending nearly the full length of the continent came with this transformation.

In contrast to the regional Paleozoic fossil record, the fossil record for the Mesozoic Era (~252 to 65 Ma) is poorly preserved in rocks exposed in the DRECP area. This is largely because most regional Mesozoic Era rocks are igneous and consist of either plutonic rocks (e.g., granite, granodiorite, or gabbro) or volcanic rocks (e.g., rhyolite, dacite, or basalt), which—based on their origin directly from molten magma—are devoid of fossil remains or traces. The few examples of Mesozoic Era sedimentary rocks, for the most part, have been altered by metamorphic processes that have destroyed their original fossil content. There are, however, a few notable exceptions, including the existence of the only known dinosaur footprints in California, preserved in Jurassic Period (~165 to 145 Ma) sedimentary rocks exposed in the Mescal Range, which is in the Kingston and Funeral Mountains ecoregion subarea.

The fossil record for the Cenozoic Era (~65 Ma to the present) is very well preserved in exposed sedimentary rocks within the DRECP area. Examples include the only known Paleocene (~60 Ma) land mammal assemblage from the western United States, which has been collected from rocks in the El Paso Mountains in the Panamint Death Valley ecoregion subarea. Important early Miocene (~23 to 19 Ma) terrestrial vertebrate fossils have been recovered from sites near Boron and in the Kramer Hills in the West Mojave and Eastern Slopes ecoregion subarea, while the North American standard for middle Miocene (~19 to 13 Ma) land mammal assemblages has been well documented in studies of numerous paleontological sites in the Gravel Hills, Mud Hills, and Alvord Mountains, located in the Mojave and Silurian Valley ecoregion subarea. Important tropical marine invertebrate and vertebrate fossil faunas document the formation of the proto-Gulf of California and the initiation of Colorado River delta deposition during the late Miocene Epoch and early Pliocene Epoch (~6 to 5 Ma). These fossils are well preserved in rocks of the western Salton Trough in the Imperial Borrego Valley ecoregion subarea. Slightly younger nonmarine strata exposed near Borrego Springs, in the Imperial Borrego Valley ecoregion subarea, preserve the most continuous record of early Pliocene through middle Pleistocene (~5 to 1.8 Ma) land mammals in North America. An extensive record of late Pleistocene (~750 to 7 kilo-annum) pluvial lake, stream, and alluvial fan fossil biotas has been recovered from the northern valleys of the DRECP area (Owens Valley, Panamint Valley, and Death Valley). The Pleistocene fossils collected from the playa-filled valleys of the Mojave Desert and Salton Trough document the dramatic climatic fluctuations that characterized the transition from glacial conditions of the late Pleistocene to the modern period.

Numerous technical reports summarizing the results of regional paleontological resource assessment and mitigation studies for renewable energy projects already built or planned in the DRECP area, contain important information on paleontological resources. Section III.10.4 discusses the information contained in these both published and unpublished reports and examines paleontological resources for each ecoregion subarea in the DRECP area.

III.10.3.2 Overview of Generalized PFYC Results

The results of the PFYC mapping, described in Section III.10.2, should be viewed as both a generalization and an estimate given the "bird's eye view" at which the classification was developed, even if it is a reasonably accurate portrayal of the relative differences among rock units and their significant yield potentials. Table R1.10-2 (in Appendix R1) lists the proposed modified PFYC classes for each of the geologic units represented in the DRECP area. The table lists the rock units in approximately stratigraphic order (i.e., youngest to oldest). The "PTYPE" field corresponds to the geologic unit symbol as shown in Figures R1.10-1 through R1.10-10. Figures R1.10-1 though R1.10.10 show the distribution of the three generalized categories of paleontological potential, by ecoregion subarea.

Exhibit III.10-1 shows the approximate distribution of PFYC classes within the DRECP area. The DRECP area is predominantly assigned an estimated/generalized PFYC class of Moderate/Unknown (53%), in large part because geologic unit "Q," which is the most extensive geologic unit, was classified as PFYC 3. Unit "Q"—which refers to *Pleistocene/Holocene marine and nonmarine (continental) sedimentary rocks*—encompasses a wide range of Quaternary units that are predominantly Holocene. In reality, most areas within Unit "Q" could likely be assigned a PFYC Class 2 if more detailed mapping confirms the area is underlain by nonsensitive units. However, because Unit "Q" could locally include Pleistocene-age or otherwise sensitive units (e.g., where such units occur in slivers or patches too small to delineate), it was assigned to Class 3 rather than Class 2.

Approximately 18% of the DRECP area is underlain by rock units estimated to have a High/ Very High PFYC class; these generally include mapped Pleistocene-age and Cenozoic-age rock units, as discussed in the following sections.

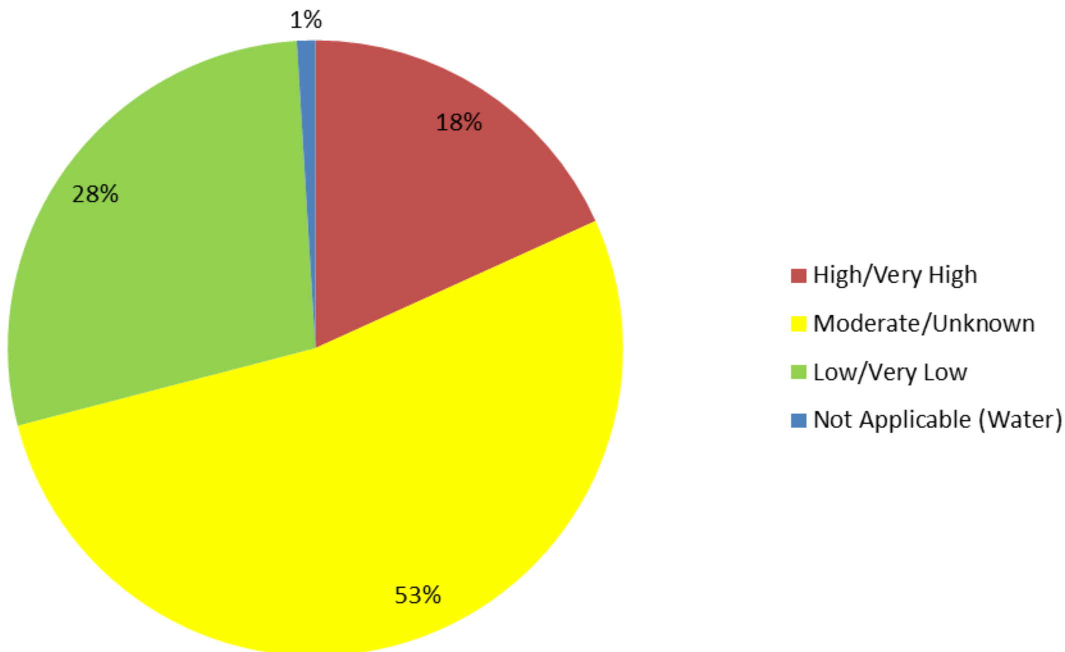

Exhibit III.10-1 Distribution of Estimated Fossil Yield Potential in the DRECP Area

III.10.4 Paleontological Resources by Ecoregion Subarea

This section discusses the geologic setting and fossil occurrences within the DRECP area, by ecoregion subarea. Table III.10-2 shows the area assigned to various levels of fossil-yielding potential (Low/Very Low, Moderate/Unknown, and High/Very High) within each ecoregion subarea, and Exhibit III.10-2 illustrates the relative amount of land within each ecoregion subarea assigned to various levels of sensitivity. The distribution of paleontological potential is fairly uniform across ecoregion subareas, though some ecoregion subareas—such as the Imperial Borrego Valley, the Cadiz Valley and Chocolate Mountains, and the West Mojave and Eastern Slopes—have a slightly higher amount of paleontologically sensitive areas compared with other ecoregion subareas.

III.10.4.1 Cadiz Valley and Chocolate Mountains Ecoregion Subarea

The BLM has designated Areas of Critical Environmental Concern (ACECs) on BLM-administered lands that contain exceptional paleontological resources. ACECs with paleontological value in this ecoregion subarea include the Mule Mountains ACEC and the Upper McCoy ACEC.

Table III.10-2
Generalized PFYC Acres by Ecoregion Subarea

Ecoregion Subarea	Not Applicable (Water)	Low/Very Low	Moderate/ Unknown	High/ Very High	Total
Cadiz Valley and Chocolate Mountains	15,000	675,000	1,578,000	795,000	3,064,000
Imperial Borrego Valley	184,000	66,000	1,597,000	553,000	2,400,000
Kingston and Funeral Mountains		782,000	1,391,000	297,000	2,470,000
Mojave and Silurian Valley	20	818,000	1,431,000	395,000	2,644,000
Owens River Valley	3,000	34,000	363,000	17,000	418,000
Panamint Death Valley	500	516,000	1,006,000	415,000	1,937,000
Pinto Lucerne Valley and Eastern Slopes		1,076,000	852,000	391,000	2,319,000
Piute Valley and Sacramento Mountains	13,000	480,000	249,000	350,000	1,092,000
Providence and Bullion Mountains	40	991,000	1,340,000	284,000	2,615,000
West Mojave and Eastern Slopes	800	903,000	2,102,000	620,000	3,626,000
Total	**217,000**	**6,343,000**	**11,909,000**	**4,116,000**	**22,584,000**

Note: The following general rounding rules were applied to calculated values: values greater than 1,000 were rounded to the nearest 1,000; values less than 1,000 and greater than 100 were rounded to the nearest 100; values of 100 or less were rounded to the nearest 10, and therefore totals may not sum due to rounding. In cases where subtotals are provided, the subtotals and the totals are individually rounded. The totals are not a sum of the rounded subtotals; therefore the subtotals may not sum to the total within the table.

Fossils known from this ecoregion subarea are limited. The oldest reported fossils are poorly preserved remains of Paleozoic marine invertebrates (e.g., crinoids) from metasedimentary (a sedimentary rock that shows evidence of metamorphism) rocks (e.g., marbles, dolostones, and quartzites) exposed in the Big Maria Mountains and Little Maria Mountains. Mesozoic-age (~120 Ma) metasedimentary rocks in the McCoy Mountains have produced mineralized angiosperm wood that has been critical in establishing the Cretaceous age of the enigmatic McCoy Mountains Formation. Cenozoic fossils are also sparse in this ecoregion subarea, with known occurrences confined to Pliocene and Quaternary rock units. Erosional remnants of the Pliocene (~5 to 3 Ma) Bouse Formation occur along portions of the Colorado River drainage including areas on the flanks of the Big Maria Mountains and the Palo Verde Mountains. The Bouse Formation has produced estuarine and marine invertebrate fossils (e.g., foraminifera, gastropods, bivalves, and ostracods) that provide critical evidence for understanding when the ancestral Colorado River started to flow westward into the proto-Gulf of California. Younger, sparsely fossil-bearing, Plio-Pleistocene lacustrine deposits in Palo Verde Valley and Chuckwalla Valley may also play a role in resolving current conflicts about the history of the Colorado River and uplift of the Colorado Plateau.

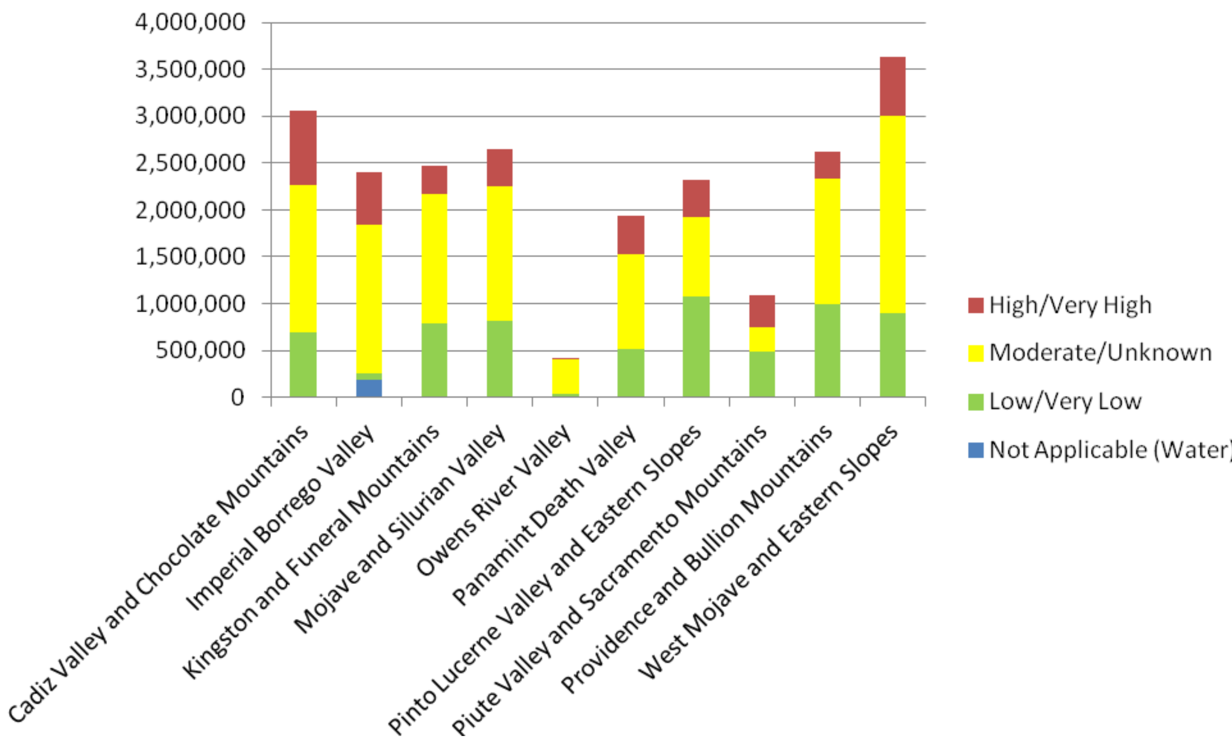

Exhibit III.10-2 Potential Fossil Yield Classification of Geology in the DRECP Area

Recent fieldwork related to renewable energy resources in the Palo Verde Valley has resulted in the discovery of vertebrate fossils in buried Pleistocene paleosols interbedded with alluvial fan deposits tentatively assigned to the Chemehuevi Formation. The paleosols are widespread and extend for at least 13 miles in some places. Preliminary radiocarbon dating suggests an age of ~13 kilo-annum (or 13,000 years ago) for the paleosols and contained fossil remains, which currently include bones of tortoises, rabbits, horses, and unidentified proboscideans (Stewart et al. 2012). Field investigation associated with a proposed power tower development west of Blythe identified several rare, unique, and well-preserved specimens. For example, one of the fossil discoveries included a clutch of unhatched desert tortoise eggs intact in a burrow accompanied by an adult tortoise—the specimen may be the only such fossil ever found in California.

Pleistocene lacustrine deposits occur in several of the larger valleys in this ecoregion subarea including Cadiz Lake in Cadiz Valley, Troy Lake in Mojave Valley, and Danby Lake in Ward Valley. At the Archer site in the Cadiz dry lake beds, fossil remains of Pleistocene amphibians, reptiles, birds, and mammals (mostly rodents) have been collected, while a more diverse Ice Age vertebrate assemblage consisting of rabbits, rodents, foxes, horses, and camels has been recovered from slightly younger lake beds at the Saltmarsh site in the Danby dry lake beds.

III.10.4.2 Imperial Borrego Valley Ecoregion Subarea

The BLM has designated ACECs on BLM-administered lands that contain exceptional paleontological resources. ACECs with paleontological value in this ecoregion subarea include the following:

- Coyote Mountains Fossil Site
- Ocotillo
- Lake Cahuilla
- West Mesa
- Yuha Basin

Fossils from this ecoregion subarea are primarily from the Borrego Valley, Vallecito Valley, Carrizo Badlands, and Yuha Basin. They generally consist of:

- Late Miocene to early Pliocene (~6 to 4 Ma) marine invertebrate fossils (e.g., corals, oysters, scallops, clams, snails, crabs, shrimp, sand dollars, and sea urchins) from strata of the Imperial Group, as well as Pliocene to early Pleistocene (~4 to 1.5 Ma).
- Terrestrial vertebrate fossils (e.g., shrews, moles, bats, ground sloths, rabbits, rodents, dogs, wolves, coyotes, foxes, short-faced bears, cave bears, raccoons, coatis, weasels, skunks, jaguars, bobcats, saber-toothed cats, mammoths, horses, tapirs, peccaries, camels, llamas, deer, and antelopes).
- Paleofloras (e.g., juniper, avocado, bay laurel, cottonwood, willow, ash, walnut, buckeye, and fan palm) from sedimentary rocks of the Palm Spring Group.

Pleistocene (~1 Ma) fossils from lacustrine siltstones and fine-grained sandstones of the Brawley Formation have also been found within this ecoregion subarea. They include well-preserved remains of freshwater mollusks (e.g., mussels, clams, and snails) and freshwater vertebrates (e.g., fish) that lived in a large, perennial lake fed by freshwater flowing north into the Salton Trough via the ancestral Colorado River.

During the latest Pleistocene and lasting almost into modern times, the Colorado River continued to alternate its flow between the Colorado River delta to the south and the Salton Trough to the north. During the times it flowed north, the full discharge of the Colorado River formed a large, freshwater lake that at maximum inundation was approximately 300 feet deep, 105 miles long, and at its widest point, some 35 miles across (Hubbs and Miller 1948; Norris et al. 1979). Widespread deposits of this lake, known as Lake Cahuilla, have produced locally diverse fossil assemblages of freshwater mollusks (e.g., mussels and snails) and bony fish (e.g., desert pupfish, bonytail chubs, and razorback suckers), as well as rare remains of terrestrial vertebrates including reptiles (horned lizards, spiny lizards, brush lizards, shovel-nosed snakes, night snakes, gopher snakes, ground snakes, sidewinders, and rattlesnakes) and mammals (e.g., cottontail rabbits, pocket mice, kangaroo rats, ground squirrels, and wood rats).

III.10.4.3 Kingston and Funeral Mountains Ecoregion Subarea

The BLM has designated ACECs on BLM-administered lands that contain exceptional paleontological resources. ACECs with paleontological value in this ecoregion subarea include the Mountain Pass/Dinosaur Trackway ACEC.

Fossils from this ecoregion subarea span an incredible range of geologic time and include some of the oldest fossils from the western United States. Proterozoic (~1200 to 800 Ma) fossils preserved in strata of the Pahrump Group occur in several mountain ranges in the ecoregion subarea (e.g., Nopah Range and Kingston Range) and include silicified remains of single-celled prokaryotes (bacteria-like organisms lacking nucleated cells) and some of the earliest known single-celled eukaryotes (organisms with nucleated cells) (Cloud et al. 1969). Fossils of Cambrian age (~540 to 485 Ma) have been collected in the Kelso Mountains (Hagadorn et al. 2000) and Nopah Range (Cooper et al. 1982) and provide important evidence of the transition from soft-bodied (e.g., Ediacaran biotas) to skeletonized multicellular animals (e.g., trilobites, brachiopods, sponges, and eocrinoids) that existed at this time. Younger Paleozoic (Ordovician through Permian; ~470 to 260 Ma) fossils have been collected from a thick sequence of marine strata exposed in the Nopah Range and Clark Mountains and include remains of corals, gastropods, stromatoporoids, and crinoids, as well as conodonts (Miller 1982). Except for the dinosaur footprints from the Jurassic-age (~165 to 145 Ma) Aztec Sandstone exposed in the Mescal Range, fossils of Mesozoic age have not been reported from rocks in this ecoregion subarea.

Cenozoic fossils are also largely unknown in this ecoregion subarea, although the local occurrence of thick sequences of Neogene and Quaternary (~23 to 1 Ma) sedimentary rocks in several areas (e.g., Clark Mountains, Shadow Mountains, Greenwater Valley, and Amargosa Desert) suggests that important paleontological resources may be recovered from these deposits. As an example, Pleistocene vertebrate fossils have been recovered from a series of valley fill deposits at the Valley Wells site in Shadow Valley that include remains of rabbits, coyotes, horses, camels, llamas, and mammoths (Reynolds et al. 1991a). A thick sequence of older Pleistocene lacustrine deposits at the southern confluence of Greenwater Valley and Chicago Valley is the result of filling pluvial Lake Tecopa, which at maximum size inundated an area of approximately 100 square miles. Vertebrate fossils recovered from these deposits include remains of rabbits, rodents, mammoths, horses, camels, llamas, and deer. These deposits also preserve footprints and trackways of Pleistocene mammals. In other parts of this ecoregion subarea, localized occurrences of Pleistocene cave deposits provide additional paleontological resources. Notable examples occur in the Ivanpah Mountains (Antelope Cave and Kokoweef Cave) and Mescal Range (Mescal Cave), where cave deposits have produced vertebrate fossil remains of reptiles (e.g., tortoises, turtles, lizards, and snakes), birds (e.g., hawks, owls, grebes, and ducks), and land mammals (e.g., shrews, bats, pikas, rabbits, rodents, coyotes, foxes, black bears, ringtails, weasels, badgers, skunks, bobcats, horses, camels, deer, pronghorns, and bighorn sheep).

III.10.4.4 Mojave and Silurian Valley Ecoregion Subarea

The BLM has designated ACECs on BLM-administered lands that contain exceptional paleontological resources. ACECs with paleontological value in this ecoregion subarea include (1) Afton Canyon, (2) the Manix Paleontological Area, and (3) Rainbow Basin/Owl Canyon.

Fossils have been reported from a number of areas within this ecoregion subarea and are primarily mid- to late-Cenozoic in age (Miocene to Pleistocene; ~23 Ma to 10 kilo-annum). The most significant fossils include those recovered from fluvial and lacustrine strata of the Barstow Formation as exposed in the Gravel Hills and Mud Hills north of Barstow and in the Calico Mountains, Daggett Ridge, and Alvord Mountains east of Barstow. These strata span much of the middle Miocene, from ~19 to 13 Ma, and have produced important fossils (bones, teeth, and footprints) of terrestrial mammals (e.g., rodents, bears, weasels, badgers, dogs, cat-like nimravids, horses, rhinos, camels, antelopes, and gomphotheres). These fossils serve as the basis for the Barstovian North American Land Mammal Age.

Vertebrate fossils continue to be discovered and studied by paleontologists from these strata, and the scientific significance of these fossils has been recognized by the Department of the Interior in the ACEC designation of the Barstow Formation exposures in the Mud Hills. The Barstow Formation has also produced exceptional fossils of freshwater invertebrates preserved three dimensionally with their soft anatomy replicated in microcrystalline silica. These fossils have been recovered from lacustrine sediments and represent species of ostracods, fairy shrimps, copepods, diatoms, larvae of diving beetles, flies and mosquitoes, and branchiopods. Younger Miocene-age (~12 Ma) strata of the Avawatz Formation exposed in the Avawatz Mountains have produced vertebrate fossils that extend the paleontological record for land mammals beyond that documented in the Barstow Formation and allow ecological and taxonomic comparisons to be made with age-equivalent mammal fossils from other areas in the region. Recovered fossils include remains of bats, foxes, bear-dogs, martens, large cats, pikas, rabbits, rodents, gomphotheres, horses, camels, and pronghorns (Whistler and Reynolds 1991).

A surprisingly diverse assemblage of Quaternary fossil invertebrates and vertebrates has been recovered from fluvial and lacustrine strata of the Manix Formation (Jefferson 2003). This rock unit was deposited during the middle to late Pleistocene (~1.0 to 0.02 Ma) in a succession of perennial lakes that at maximum high stand created a large three-lobed lake (Lake Manix) that inundated more than 250 square miles along the ancestral Manix River east of Barstow. Invertebrate fossils from the Manix Formation include freshwater mussels, clams, snails, and ostracods that lived during cooler and wetter glacial periods of the Pleistocene. These fossils occur in association with a diverse freshwater vertebrate assemblage dominated by bony fish, pond turtles, and aquatic migratory birds (e.g., loons, grebes, pelicans, cormorants, storks, flamingoes, swans, ducks, coots, and sandpipers). Alluvial strata in the Manix Formation have also produced important fossils of Ice Age land mammals including ground sloths, rabbits, mice, dire wolves, coyotes, short-faced bears, mountain lions, scimitar-toothed cats, horses, camels, llamas, antelopes, mountain sheep, ancient bison, and mammoths.

These fossils and the sedimentary rocks that contain them serve as an archive documenting the transition from the cooler and wetter glacial conditions of the Pleistocene and the warmer and drier conditions of today. Farther northeast, the ancestral Mojave River flowed out of Lake Manix and continued downstream into pluvial Lake Mojave, deposits of which have the potential to contain additional significant paleontological resources similar to those documented from Lake Manix. During the height of glacial conditions, the Mojave River flowed north out of pluvial Lake Mojave to join with surface flows of the ancestral Amargosa River to eventually flood the Death Valley region, thus forming pluvial Lake Manly. The Bitter Springs Playa deposits in the Tiefort Basin at the Fort Irwin National Training Center have produced a diverse assemblage of Pleistocene vertebrates that includes fossil remains of reptiles (e.g., tortoises, snakes) and land mammals (e.g. rabbits, rodents, coyotes, dire wolves, short-faced bears, American lions, saber-toothed cats, mammoths, horses, camels, llamas, and deer). Pleistocene fossils of ground sloths, wild dogs, jaguars, and horses have also been collected from this site.

Extensive sequences of Pleistocene lacustrine and alluvial fan deposits occurring in the valleys adjacent to the Granite Mountains might contain additional remains of terrestrial vertebrate fossils.

III.10.4.5 Owens River Valley Ecoregion Subarea

Fossil occurrences in this ecoregion subarea are primarily limited to those preserved in the Pleistocene lake beds associated with ancient Owens Lake. At several sites in Owens Valley, Pleistocene pluvial lake deposits have produced vertebrate fossils, including remains of birds, rodents, extinct cats, proboscideans, horses, camels, and bison (Jefferson 2010).

III.10.4.6 Panamint Death Valley Ecoregion Subarea

Fossils from this ecoregion subarea are limited but preserve significant records of life in this part of the Great Basin. The fossil mammalian fauna recovered from the Goler Formation in the El Paso Mountains represents the only diverse assemblage of Paleocene vertebrate fossils from California and provides a unique opportunity to understand regional conditions of faunal exchange and evolution during the early part of the Age of Mammals. Pleistocene pluvial lake deposits associated with Lake Rogers and Lake Dumont in the Death Valley region have produced fossil remains of pond turtles, cormorants, ducks, coots, camels, and mammoths (Jefferson 2010), and document the dramatic ecological changes in this region just since the end of the most recent Ice Age.

A literature and records search was completed for the Death Valley National Park region by Robert E. Reynolds, curator, Earth Sciences, in the San Bernardino County Museum in Redlands, California. The records and literature search identified a number of potentially sensitive fossiliferous areas within the park area. Significant paleontological resources and records relating to paleobiostratigraphic events that occur within or near the park include (Nyborg and Santucci 1999):

- The world's oldest mitosing cells, 990 million years old, preserved in silica in the Beck Spring Formation.
- Significant Cambrian trilobite and invertebrate fossil localities that mark the boundary of the Paleozoic Era, 555 million years old.
- Significant occurrences of Paleozoic invertebrate fossils and the possibility of very old fossil fish in Death Valley National Park.
- Panamint Range localities that contain significant marine cephalopods and invertebrate fossils.
- The early record of the Oligocene Tertiary Era from north of the Mojave Desert, found in the Grapevine Mountains in Death Valley National Park; important fossils including rodents, canids, horses, helaletids, brontotheres, rhinoceros, oredonts, and leptomerycids.

Extremely important Late Miocene trackways, associated with important vertebrate fossils, occur in the Black Mountains in Death Valley National Park and in the Avawatz Mountains south of the park (see Section III.10.4.4, Mojave and Silurian Valley Ecoregion Subarea). The Black Mountains area includes a wide range of camels, horses, gomphotheres, and aquatic bird trackways associated with a shallow freshwater lakeshore.

III.10.4.7 Pinto Lucerne Valley and Eastern Slopes Ecoregion Subarea

At the Rabbit Springs site in the Lucerne dry lake beds, remains of horses and possibly camels have been reported. Other Pleistocene playa lake beds in this region might produce similar and possibly more diverse vertebrate fossil remains. On Marine Corps Air Ground Combat Center Twentynine Palms, paleontological reconnaissance efforts have discovered Pleistocene vertebrate fossils associated with early Pleistocene-age (~2 Ma) alluvial fan deposits. Collected fossils include well-preserved remains of freshwater fish, salamanders, frogs, toads, giant tortoises, snakes, shore birds, ground sloths, shrews, pikas, rabbits, rodents, ringtails, horses, peccaries, camels, llamas, and deer. The Pinto Basin between the Pinto Mountains and the Eagle Mountains has recently begun to yield an increasingly diverse assemblage of Pleistocene marine vertebrates that includes birds (e.g., ducks and hawks) and mammals (e.g., rabbits, badgers, dogs, mammoths, horses, camels, llamas, antelopes, deer, sheep, and bison).

Dry caves in the region have produced localized occurrences of late Pleistocene to early Holocene vertebrate fossils including those at Newberry Cave and Schuiling Cave in the Newberry Mountains, where remains of reptiles (e.g., tortoises, chuckwallas, and rattlesnakes), birds (e.g., ducks, condors, hawks, coots, and owls), and land mammals (e.g., ground sloths, rabbits, rodents, coyotes, foxes, raccoons, badgers, pumas, bobcats, horses, camels, llamas, pronghorns, and bighorn sheep) have been collected.

III.10.4.8 Piute Valley and Sacramento Mountains Ecoregion Subarea

Fossils known from this ecoregion subarea are very limited and primarily associated with the older Pleistocene alluvial fan deposits and correlative fluvial sediments broadly referred to as the Chemehuevi Formation. These fossils consist of sparse remains of freshwater fish. However, elsewhere along the Colorado River drainage, strata assigned to the Chemehuevi Formation have produced more diverse fossil assemblages that include freshwater mollusks and ostracods, birds, and land mammals (horses, antelopes, and mammoths). This record suggests the potential for additional discoveries of Pleistocene vertebrate fossils in the region. In addition, the potential exists for the discovery of Pliocene fossils in isolated, erosional remnants of the Bouse Formation in the area.

III.10.4.9 Providence and Bullion Mountains Ecoregion Subarea

The BLM has designated ACECs on BLM-administered lands that contain exceptional paleontological resources. ACECs with paleontological value in this ecoregion subarea include the Marble Mountain Fossil Bed ACEC.

Fossils from this ecoregion subarea span a range of geologic periods from the early Paleozoic (~520 Ma) to the late Pleistocene (~10 kilo-annum). Carbonate strata exposed in the New York Mountains, Providence Mountains, and Marble Mountains have produced some of the best-preserved evidence of Cambrian (~515 Ma) life from California. This is especially the case for outcrops of the Latham Shale in the southern Marble Mountains, where a diverse assemblage of shallow marine invertebrates has been recovered that includes remains of trilobites, the bizarre *Anomalocaris*, early articulate brachiopods, strange hyoliths, and eocrinoids. Younger Paleozoic (Devonian through Permian) marine sedimentary rocks crop out in the Providence Mountains and have produced fossil remains of a variety of marine invertebrate animals including fusulinids, corals, brachiopods, gastropods, bivalves, trilobites, and crinoids.

Cenozoic fossils known from this ecoregion subarea include a temporal succession of terrestrial vertebrates collected from the Miocene-age (~21 to 15 Ma) Hector Formation as exposed in the Cady Mountains. The oldest fossils in this rock unit predate the more diverse assemblages of the Barstow Formation and include age-significant species of oreodonts, camels, and carnivorans. Slightly younger strata of the Hector Formation cropping out in the northern Cady Mountains have produced additional mammalian fossil remains including those of mice, beavers, dogs, horses, rhinoceros, camels, and antelopes.

Dry caves in the region have yielded localized occurrences of late Pleistocene to early Holocene vertebrate fossils including those at Mitchell’s Caverns in the Providence Mountains where remains of reptiles (e.g., tortoises), birds (e.g., coots, roadrunners, and crows), and land mammals (e.g., ground sloths, rabbits, rodents, foxes, ringtails, bobcats, horses, camels, and sheep) have been collected. As with other playa lakes in the sediment-filled basins of the Mojave Desert, those in this ecoregion subarea contain fossil remains of animals that lived in and around Pleistocene pluvial lakes. A good example is represented by paleontological work in Fenner Valley, which recovered a diverse assemblage of middle to late Pleistocene vertebrates including amphibians (e.g., toads), reptiles (e.g., tortoises, lizards, and snakes), birds, and land mammals (e.g., rabbits, rodents, cats, camels, and antelopes).

III.10.4.10 West Mojave and Eastern Slopes Ecoregion Subarea

The BLM has designated ACECs on BLM-administered lands that contain exceptional paleontological resources. ACECs with paleontological value in this ecoregion subarea include the Horse Canyon ACEC.

Fossils have been reported from a number of areas within this ecoregion subarea and are primarily mid- to late-Cenozoic in age (Miocene to Pleistocene; ~23 Ma to 10 kilo-annum). Miocene fossils from north of the Garlock Fault include significant assemblages of land plants and mammals from the Bopesta Formation (~16 to 12 Ma; Quinn 1987) in the eastern Tehachapi Mountains. An even more diverse assemblage of reptiles (e.g., turtles, lizards, and snakes), birds (e.g., ducks and hawks), and mammals (e.g., bats, hedgehogs, foxes, bear-dogs, bears, cats, ringtails, badgers, skunks, squirrels, beavers, mice, gophers, rabbits, gomphotheres, rhinoceros, horses, oreodonts, peccaries, camels, and antelopes) has been recovered from the Dove Spring Formation (~13 to 7 Ma; Whistler and Burbank 1992). These are exposed in Red Rock Canyon State Park at the east end of the El Paso Mountains. South of the Garlock Fault near the town of Mojave, younger Miocene mammal fossils (e.g., bats, moles, rabbits, mice, dogs, bears, saber-toothed cats, gomphotheres, horses, rhinoceros, peccaries, llamas, camels, and pronghorns) have been reported from the Horned Toad Formation (~6 to 5 Ma; May et al. 2011). Away from the mountains, early and middle Miocene fossils have been reported from a few isolated locations including the open pit borate mine near Boron (Whistler 1984), where alluvial and lacustrine strata of the Tropico Group (~21 to 18 Ma) produced a small vertebrate assemblage (e.g., lizards, snakes, rabbits, squirrels, mice, oreodonts, camels, and antelopes). Additional Miocene vertebrate fossil discoveries have been made in the Kramer Hills, in the Bissell Hills, and at Edwards Air Force Base, where paleontological surveys resulted in the collection of land mammal fossils (Reynolds 1988).

Pleistocene vertebrate fossils have been reported from a number of sites in this ecoregion subarea and include the discovery of bones and teeth of freshwater fish (e.g., sticklebacks), amphibians (e.g., toads), reptiles (e.g., lizards and snakes), and land mammals (e.g., rabbits, rodents, badgers, coyotes, ground sloths, horses, camels, bison, and mammoths) from sediments of pluvial Lake Thompson near Rosamond (Reynolds and Reynolds 1991; Wilkerson et al. 2011). This lake may have inundated an area up to 200 square miles during the late Pleistocene, including the present-day Rosamond and Rogers playa lake beds. Additional reports of fossils from pluvial lake deposits in this ecoregion subarea come from Harper Dry Lake in Harper Valley and Searles Dry Lake in Indian Wells Valley.

III.10.5 Paleontological Resources—Affected Environment Outside the DRECP Area

Similar to the DRECP area, in the larger context of the Southern California region, specific locations and geologic units are known to yield fossils. There are also areas that have not been studied and for which little information exists on the potential for paleontological discoveries. These sensitive areas vary locally and regionally and depend on factors of the geologic environment that are site-specific. Certain generalizations can be made about the potential for various rock units to yield paleontological resources (e.g., sedimentary rocks of Pleistocene-age or older that can be fossil-rich versus granitic rocks that are devoid of life).

Section III.10.1 provides the regulatory setting for paleontological resources. Regulations and guidelines also include the PRPA, California Desert Conservation Act Plan, BLM Bakersfield Field Office Proposed Resource Management Plan, BLM Eastern San Diego County Field Office Resource Management Plan, and National Park Service Reference Manual #77—Paleontological Resources Management. State regulations include the California Public Resources Code Section 5097.5 and Code of Regulations, Sections 4307 and 4309.

The corridors anticipated to be used in future transmission outside the DRECP area are existing transmission corridors in four geographic areas: San Diego, Los Angeles, North Palm Springs–Riverside, and Central Valley. Each has varying degrees of disturbance from previous transmission line construction, which involves ground disturbance to develop or upgrade access roads and augur holes to pour concrete foundations at tower locations. Nevertheless, new transmission lines would require new foundations and, in some cases, new or upgraded access roads. The ground disturbance could impact unknown paleontological resources.

III.10.5.1 San Diego Area

This transmission corridor extends from Ocotillo, in southwestern Imperial County, to San Diego, roughly following the existing Sunrise Powerlink corridor westward. There are geologic units in the San Diego area with moderate and high sensitivity for the presence of fossils. Examples of previous finds include marine invertebrates and vertebrates, mollusks, terrestrial mammals (deer, horses, camels, bison, mammoths, saber-toothed cats, sloths, short-faced bears), reptiles, birds, and fossilized plants.

III.10.5.2 Los Angeles Area

This transmission corridor extends from the Palmdale area to the Los Angeles Basin roughly following Segments 6, 7, and 11 of the Tehachapi Renewable Transmission Project. There are geologic units in this area with a moderate to high sensitivity for the presence of fossils.

Examples of previous finds include marine snails, clams, brachiopods, marine fish, baleen whales, mammoths, and ground sloths.

III.10.5.3 North Palm Springs–Riverside Area

The North Palm Springs–Riverside transmission corridors extend from the Devers Substation near Palm Springs to the Rialto, Lugo, and Valley substations in San Bernardino County, following part of the existing Devers–Palo Verde No. 2 corridor. There are geologic units in this area with moderate to high sensitivity for fossil finds. Examples of previous finds include gastropods, bivalves, shallow marine invertebrates, birds, reptiles, fish, and terrestrial mammals (mammoths, saber-toothed cats, ground sloths, short-faced bears, horses, and camels).

III.10.5.4 Central Valley Area

This transmission corridor is the longest of the four, extending from Rosamond in the Northern Mojave Desert to Tracy, roughly following the existing Path 15 and 26 transmission corridors and Interstate 5. There are geologic units in the Central Valley with moderate to high sensitivity for the presence of fossils. Examples of previous finds include dinosaurs, plesiosaurs, mosasaurs, turtles, sharks, bony fish, mollusks, and other marine and freshwater fossils.